Cathodes for Sediment Microbial Fuel Cells

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1. Background

(Plant) Sediment MFC's have a traditional configuration:

- Cathode above, in the water layer.
- Anode below, in the sediment.

Drawback: large distance between anode and cathode and a thick "membrane" (= sand/soil layer).

Proposed improvement:

- Cathode <u>in</u> the sediment, next to Anode.

1) Does the new cathode configuration lower internal resistance?
2) How efficient is COD Removed?

2. Measurements

- Polarization curves followed by current interrupt (15 min stabilization) on anode connected to bottom or top cathode.
- Internal resistance was calculated by R_{int}=dV/J (R [Ωm^2]; dV [V], voltage drop 10 ms after current interrupt; J [A/m^2], current drop during current interrupt).

<u>Reactor operation</u>

- Daily additions of water with to create a downward flux, with organic carbon ("Rhizodeposits") at 30 mgCOD/L/d ~ 5,5 gCOD/m^2/d.

3. Reactor setup

<u>Setup A (drain tube):</u>

Cathode is a drain tube filled with graphite granules and wrapped with cloth.

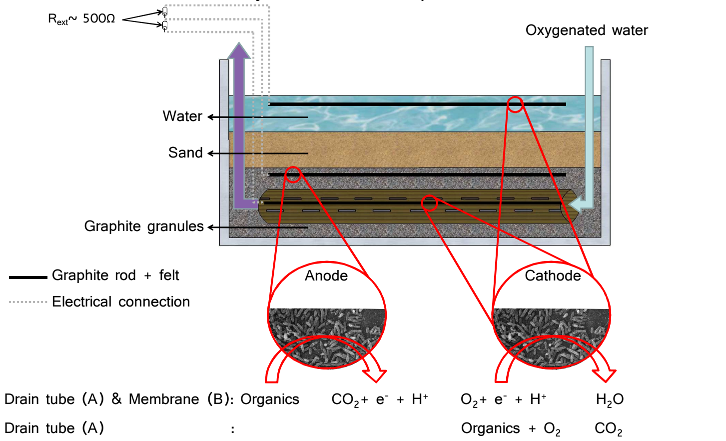
Hydraulic connection between anode and cathode liquor.

<u>Setup B (membrane):</u>

Cathode is a tubular cation exchange membrane filled with graphite granules.

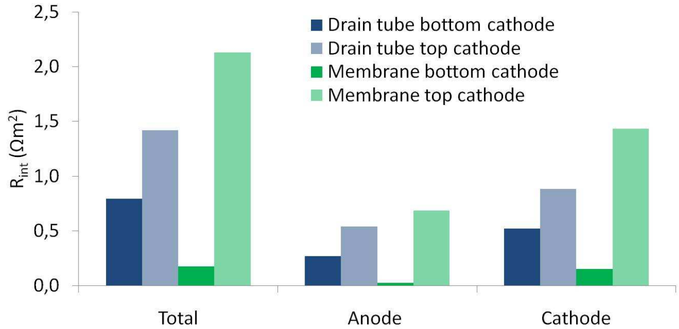
No hydraulic connection between anode and cathode liquor.

Hence outflow of reactor A contains COD and used cathode liquid, outflow reactor B contains only used cathode liquid.



4. Results & Discussion

4.1 Results: Internal resistance

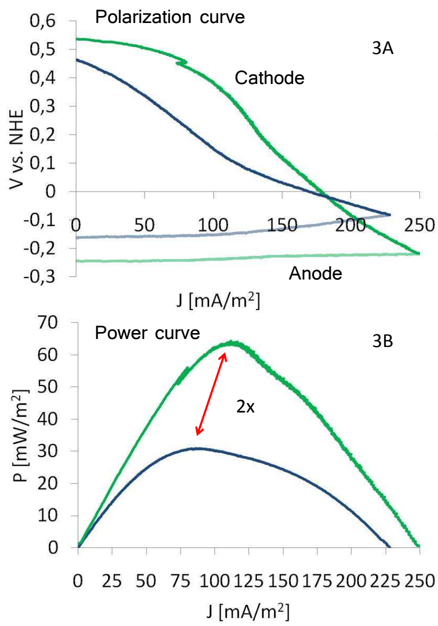


- Internal resistance of the bottom cathode is lower than with the top cathode.
- Smallest Internal resistance is measured with the cation exchange membrane present.

4.2 Results: Organics removal

- Current production accounts for 2,15% (drain tube) and 2,26% (membrane) of daily added COD.
- Effluent COD concentration of setup A (drain tube) was ~ 60 mg/L vs. 460 mg/L for setup B (membrane).

4.3 Results: Potentials, Power & Oxygen



<u>Potential & Power</u>

Due to complete separation of anode and cathode, potentials are more stable (3A) in a setup with a membranous cathode resulting in a 2x higher power output (3B) as compared to a setup with a drain tube cathode.

<u>Oxygen</u>

In this system during the polarizations, oxygen supply to the cathode was not limiting as the cathodic effluent still contained 5,5 mg/L for setup A (drain tube) and 7 mg/L for setup B (membrane).

5. Conclusions & Perspectives

- These results indicate that a sediment MFC with a cathode in the bottom has the potential to be more powerful compared to a cathode in the above water layer due to the lower internal resistance.
- Organics removal is higher with a drain tube bottom cathode, mainly due to aerobic removal as eletricigenic organics removal was equal in both reactors.
- Separation of anode and cathode results in a 2x power increase.
- Applications can be in constructed wetlands, greenhouses or sand filters for: remote power generation or enhanced COD removal & monitoring

SEVENTH FRAMEWORK PROGRAMME

Acknowledgements.

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